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MAPPING APPLICATIONS OF VIDEO DISC TECHNOLOGY(U) ARMY  
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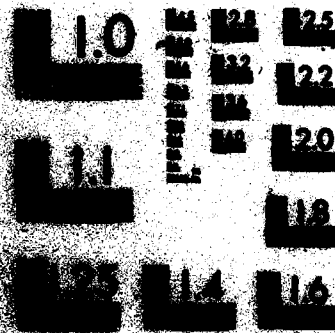
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## MAPPING APPLICATIONS OF VIDEO DISC TECHNOLOGY\*

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### ABSTRACT

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Video discs can store large quantities of analog map products in a compact, nonvolatile format. Interfacing them to microcomputers provides a portable, rugged means of accessing cartographic information. This new technology has many potential applications in map data storage, navigation, training, and mission making. The U. S. Army Engineer Topographic Laboratories (ETL) is studying hardware, software, and map design aspects of video discs with a prototype Map Video Processing (MVP) system.

### INTRODUCTION

Optical-reflective video discs permanently store large amounts of data using a method known as optical-recording (Signal, E., et al., 1980). First, the information is converted into a video signal and recorded onto video tape. The tape then drives a high power laser beam burning pits into a master disc surface. Finally, the master disc serves as a pattern for stamping out multiple copies of itself onto plastic discs. To read the data, the plastic disc is inserted into a special video disc player. The disc is rapidly rotated while a low power laser beam shines on its reflective surface. The beam is reflected back to a photodiode that senses intensity differences due to patterns of pits on the disc face. This is converted back into a video signal and displayed on a television monitor. A microcomputer can be interfaced with the video disc player to produce an interactive system (Figure 1).

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These plastic discs are quite durable, and handle like ordinary phonograph records. Unlike magnetic tape or video tape, any information on the disc is accessible in a few seconds or less. Also, unlike magnetic tapes or magnetic disks, they are not affected by magnetic interference, or reader head crashes due to dust buildup. For this reason video discs should last longer in storage than magnetic media. They take up little space, and may be stored in the same manner as phonograph records. Even the video disc/microcomputer combination can fit on a table top. Thus, video disc systems can operate in cramped, dirty environments. Their major disadvantage is that they are unerasable. Once the pattern of pits is put on the disc surface, it cannot be altered and used again. However, this will change when new erasable video discs become commercially available in 1984.

Anything that can be put on video tape can be put onto video disc (McClain, 1983). This includes digital data, as well as analog products like still photographs, movies, video tape, drawings, and maps. Light, 1983 offers an estimate of digital map data storage using this new technology. This paper concerns itself with analog map storage on video disc. It first describes the major hardware and software considerations for utilizing video discs in mapping. It then lists potential mapping applications of video discs. Finally, it describes work USAETL is doing in this field.

### STORING MAPS ON VIDEO DISCS

Map products are transferred to video disc using precision photography or video taping. The map is first placed down on a flat surface. A video or movie camera is then guided over the map through a computer controlled sequence. It records sections of the map as individual photo or video frames in much the same way aerial photographs are taken over a land area. A master video tape is made of these frames, and this tape is used to make the video disc master. The final video disc holds up to 54,000 frames per side, or 108,000 frames for a two-sided disc. Each individual frame is identified by a frame number, much like the page number of a book. In fact, the video disc may be thought of as an atlas with 54,000 individual maps.

The total number of frames needed to cover a map depends on three major parameters (Levine, 1983):

**Frame Size-** This represents the area of the map covered by each frame. Unfortunately, the video signal from the video disc displays a high resolution scene (the map) on a low resolution television screen, typically of 525 raster lines (Caldwell, 1981). As the camera covers a wider area of the map, a certain point is reached where map detail becomes almost impossible to read on the television screen (Wong and Yacouelos, 1970). Thus, as frame size is increased, less frames are needed to completely cover the map. However, at the same time, map detail becomes unreadable. Likewise, as frame size is decreased, map detail becomes quite clear on the raster screen. Yet, many more frames are required to cover the map. The key is to find a frame size covering a



Figure 1

Table 1  
VIDEO DISC STORAGE CAPACITIES  
(After Levine, 1983)

Disc Size (cm)	Frame Size (lines)			Total No. Frames per Map	No. Maps per Video Disc	No. Video Discs Covering Central Europe
	5	10	20			
6	100	25	9	134	402	9
12	200	50	16	266	203	18
18	400	100	25	525	102	35
24	1600	400	100	2100	25	140



amount of area, while still showing an acceptable amount of map detail. Determining this can be very difficult.

**Frame-to-Frame Overlap**-This represents the amount of overlap between individual frames. This is used in the panning or zooming features described below. The camera typically takes frames in a north-south, east-west direction. The result is overlap in these directions only. However, the camera could also overlap frames in diagonal directions of northeast-southwest, or southeast-northwest. As overlap increases, so does the number of frames needed to cover a map.

**Number of Levels**-This relates to different scales of frames used to completely cover the map. A single map can be covered by more than one frame size. This would result in different levels of scale being used in the zoom feature described below. As the number of levels increases, so does the number of frames required to completely cover a map.

Because of the above complicated process, there is much confusion about just how many maps may be stored on a video disc. This depends on how the three parameters were used to determine the number of frames. For example, central Europe, measuring approximately 1,500,000 square kilometers (km) in size, is approximately covered by about 1,500 maps at 1:50,000 scale. If each map is 100 frames (each map, then only 3,500 frames (each video disc) would be needed to cover the entire area. But the resulting images displayed on the video disc would be almost completely unreadable. This is a very realistic estimate. The second column of the table shows the storage capacities of video discs in frames. For overlaps ranging from 0 to 75%, and frame sizes of 5 to 20 centimeters (cm), and three scale levels, the number of frames needed to cover a 1:50,000 scale map at each frame size and overlap combination. For comparison, a standard map is approximately 50 x 50 cm.

Table 1 shows that the number of single-sided video discs needed to store the maps could vary from nine for 0% overlap to 144 for 75% overlap. This may seem like a lot, but even 144 video discs occupy far less space than a set of maps. For double-sided video discs, the number would be halved, but at present, single-sided video discs are more common.

#### ACCESSING MAPS FROM VIDEO DISCS

The ability to store maps on video disc is determined by several factors. The first factor, which is often overlooked, is how well the maps were put on the video disc. If the map quality is bad, or the frame size too small, or the overlap too small, then no amount of hardware will help. Many mapping discs on the market are unusable because too little consideration was given to the three parameters stated above.

The second factor is the hardware interfaced with the video disc player. A truly interactive video disc system could consist of:

- \* One or more video disc players.
- \* 8-bit or 16-bit microcomputer.
- \* Two floppy disk drives.
- \* One hard Winchester type disk drive.
- \* Several frame storage buffers.
- \* Touch panel controlled television monitor.
- \* Light pen.
- \* Joystick.
- \* Digitizing pad.
- \* Facsimile printer.
- \* Line printer.

The third consideration is software written for this system. This software locates individual frames by finding their frame number on the video disc, and displaying each frame on the screen. This is basically where the role of the video disc ends, and the role of the hardware/software begins. With properly written software this system could do the following:

**Zooming** - Using the touch panel control, the operator could simply touch a spot on a general map of an area. The computer would then pull different levels of frames off the video disc to zoom in on that area. The zoom effect will be "jumpy" or "smooth" depending on the number of levels built into the video disc. Frame size and amount of overlap among frames determines how close the frames come to zooming on the spot pointed at.

**Pan or Scroll** - At each level, the operator could pan north, south, east, or west using the joystick. To do this, the computer rapidly displays consecutive frames from the video disc to give the illusion of motion across the screen. The effect will be "jumpy" or "smooth" depending on the amount of overlap between individual frames.

**Multiple Frame Digitizing** - Different frames could be pulled off the video disc and stored in the frame buffers. Or, the computer could pull one frame each off of different video disc players. The frames could then be overlaid on top of each other on the television screen. Map separates, for example, could be put on the video disc, and combined on the screen to produce a composite map.

**Four Frames or Mosaicking** - The television screen could be divided into four separate sections. Four frames could be pulled from the video disc, and these fused or mosaicked onto the screen, producing a composite map. This could be done with four video disc players connected to the computer using the same technique. Large scale and small scale views of an area could be displayed on the same screen.

**Image Signal Processing** - Since the map is a video signal, image processing techniques could be applied to it. The computer could bring out important features and suppress



features from the displayed map. A good example is the use of contour lines above cluttered cultural features.

**Computer Graphics Symbol Placement-** Computer graphics programs on the microcomputer would allow placement of a wide variety of symbols on the screen. Figure 2 shows a touch panel controlled menu at the bottom of a map frame from the video disc. The operator need only touch the menu, point to what the symbol should go, and it will automatically appear over the map (Figure 3). Screen positions of these symbols could be stored on floppy disks. Thus, whenever a particular frame is called up, symbols covering it would be automatically displayed on the screen.

**Computerized Referencing-** Precision filming of the maps allows software to be written modeling their geographic reference system. Thus, the operator could call up a frame on the touch panel controlled screen, and point to a spot on it. The computer would then calculate the point's geographic coordinates. Pointing to two points would result in a distance and bearing being displayed. The operator could also place symbols on the screen by inputting their geographic coordinates.

### MAPS APPLICATIONS FOR VIDEO DISCS

The video disc system could find uses in many applications, such as navigation, training, and decision making. Here are just a few possibilities:

**Map Library.** Probably the greatest advantage of video discs is the space for storage of mapping information. A video disc can store, and when the above considerations of storage and retrieval are taken into account, can hold as much information as this cabinet. When coupled with a microcomputer, the video disc offers greater flexibility than any map library. Graphics overlays on the microcomputer, such as military unit symbols, could be placed on top of the background map stored on the video disc. In a more powerful system, a minicomputer could be connected to the video disc player, and advanced features, such as digitized elevation data, can be overlaid over the video disc frames.

**Map Product Catalog-** Map product listings could replace the cumbersome, confusing paper catalogs. By using the features of an interactive video disc system, the problems in locating map products could be solved. Such a system could be placed on the counter at a bookstore. For example, the user could point to a point on a map of the world on a touch panel controlled video disc. The interactive system could then display examples of map products for that area. A current map listing could be printed out by the microcomputer. Updated video catalogs could be issued just like updated map catalogs.

**Map Overlaying-** Video disc systems could duplicate the effect of maps with plastic overlays and light tables.



Figure 2



Figure 3

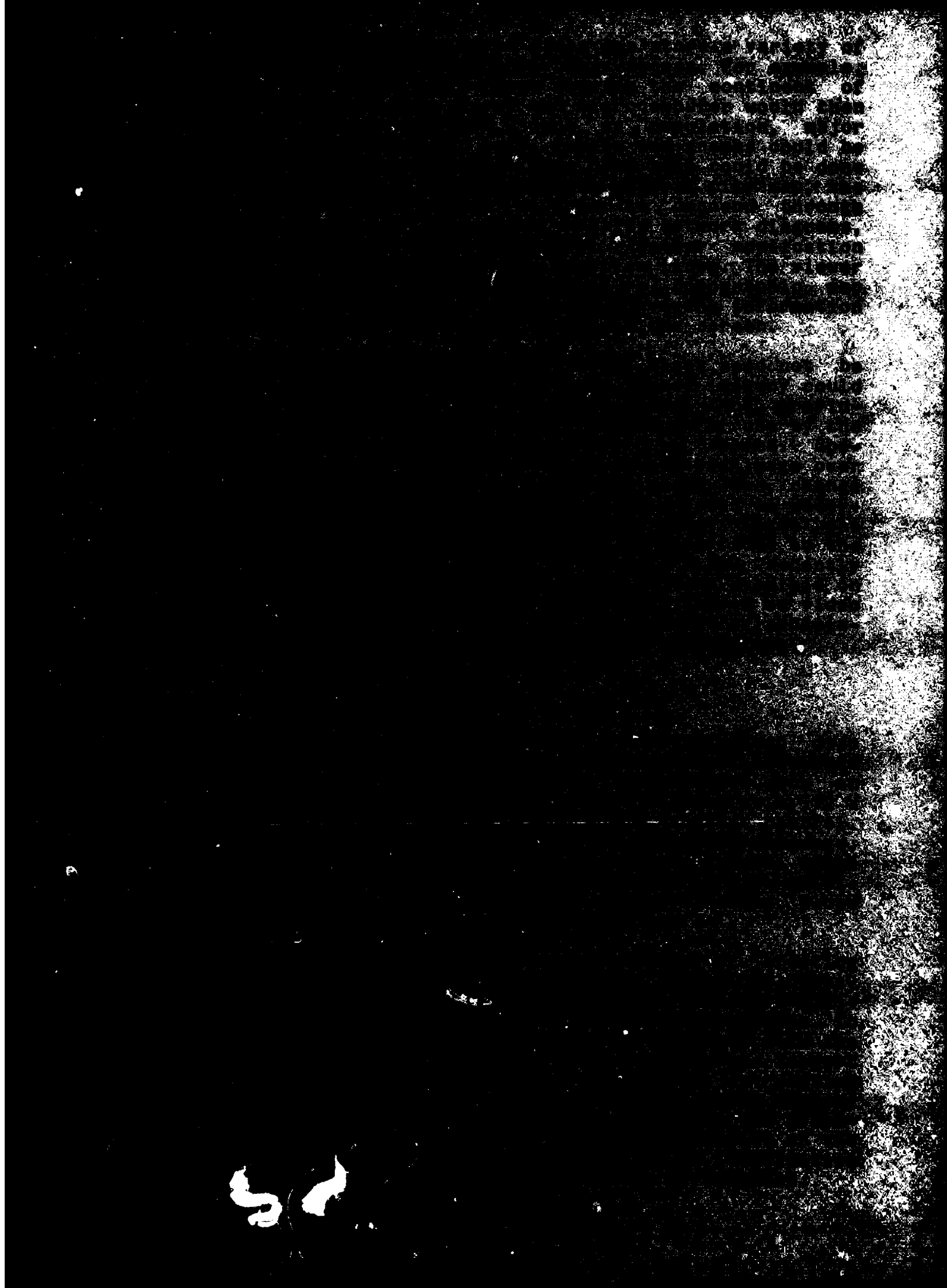
Different terrain analysis maps, land use maps, and color maps could be put on the disc through precision filming. The operator could then overlay them on the television screen using frame buffers. All materials would register so long as they used identical map projections and filming techniques. Thus, one could create individually tailored map graphics by pulling the proper frames off the video disc.

**Map Teaching Aid-** Video disc systems also could serve as a useful educational tool for teaching map reading. Specific examples of maps could be brought up onto the screen, and the student asked by the microcomputer to perform different tasks using these map graphics. For example, the student could be asked to find different symbols, measure the distance between two different points, or describe different landmarks based on their contour lines. This method would save time, since the computer could pace the student through a lesson, give tests, and monitor the student's progress. In the long run, it would also save in materials costs, since reusable video discs store all maps needed for the course.

**Storing Terrain Views Storage-** High quality perspective terrain views can presently only be generated by mini-computer systems. Video discs could serve as a storage medium for these scenes. For example, these views could be generated for important points in a geographic area and stored as individual frames on video disc. The operator could point at one of these points, and use the joystick to rotate the horizon. The microcomputer would display the view, and create a scrolling effect. If 72 terrain views were captured on every 3 degrees of azimuth) were generated for each ground point, then 1500 panoramas could fit on a standard video disc. The microcomputer could also have access to a digital elevation data base stored on hard magnetic or optical disk. Using this data base, it could generate new perspective terrain views for any specific point, much like those stored on video disc.

**Map Teaching Aid-** In cramped aircraft, instead of using a map, the pilot could view the same map on a television screen. This system could also be used in ground vehicles, such as cars, tanks, and trucks. Static maps, pregenerated perspective terrain views, video tapes, and films of avenues of approach could be stored on the video disc as well. Thus, the operator could view an area via the video disc, before actually entering it.

**Map Teaching Aid-** An interactive video disc system could be used to show dynamic phenomena as military movement or terrain changes. The background video map would appear on the screen, and different symbol graphics generated over it. Flashing dots, for example, could show the movement of different vehicles, aircraft, or units. The operator could input new information using light pen or keyboard. Since the map is video based, it could be transferred to other terminals on vehicles, ships, or air-



Since maps on a television screen are a new medium of map display, some research is needed into the graphic design of map products to best take advantage of this technology. Therefore, USAETL has undertaken a graphic design study to develop standards and recommendations for putting symbology on a map to appear with maximum clarity on the television monitor. This research will help create better map graphics for use with video technology. USAETL is also looking at integrating perspective terrain views with maps and imagery on video discs.

### CONCLUSION

Utilizing video disc technology for mapping applications requires a knowledge of the many hardware and software limitations of video discs, video display equipment, and the microcomputers that control them. Unfortunately, research in this field is scattered among many academic, commercial and government organizations. Guiding literature on the subject is almost nonexistent. Video discs, however, have great potential for mapping. Their great capacity to hold maps, graphics, and imagery solves the major problem of where to store large quantities of paper materials. They can be integrated into a rugged, compact, stand alone system for almost any application the map user might want.

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